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Partitioning of Ge/Si and Si-stable isotopes during weathering of granites and basalts: A reactive transport perspective

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Si-stable isotopes ($\delta^{30}Si$) and Ge are tracers of fluid-mineral reactions during weathering of silicate minerals. Partitioning occurs during incongruent weathering, as secondary clays become enriched in light-Si isotopes (i.e., ^{28}Si) and Ge. Thus, their partitioning is largely controlled by the type of secondary clays and the pace at which these different weathering products accumulate. Incongruent weathering of granites and basalts produces different secondary minerals: granitic weathering profiles are characterized by crystalline clays such as kaolinite or halloysite; whereas short-range order minerals such as allophane or imogolite are ubiquitous in basaltic profiles. Here, we present a series of reactive transport models to investigate the first-order controls on the partitioning of $\delta^{30}Si$ and Ge/Si ratios during weathering of two igneous lithology endmembers: granite and basalt. Using the reactive transport framework, we are able to track both tracers in analogous models to test the effects of varying secondary mineral precipitation rates, fluid transit times, soil respiration, and organic acids. Our modeling results allow us to generate quantitative predictions of $\delta^{30}Si$ and Ge/Si partitioning in the Critical Zone and illustrate the viability of a combined multi-tracer approach for investigating fluid-silicate interactions in such systems. Our efforts aim to provide a consistent framework for each tracer that can improve our understanding of silicate weathering dynamics in the past and present.